ÅGESTA – THE SUBURB NUCLEAR POWER PLANT: THE POSSIBILITIES OF RE-USE AND LARGE-SCALE PRESERVATION OF A RADIATION-CONTAMINATED POWER PLANT

Plenary session B

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INTRODUCTION

In Sweden there are ten power-producing nuclear reactors at three plants in operation. Nuclear power accounts for about half of the electricity generated in the country. As a result of a national referendum in 1980, and an Act to decommission nuclear power ratified in 1997, all reactors and all radioactive waste is to be decommissioned. Four reactors have been shut down during recent years, the best known being probably Barsebäck, which is close to the Danish border. The decision to stop using nuclear power has been a topic of lively debate for many years in Sweden.

The nuclear power industry as cultural heritage is a phenomenon that is rarely investigated in Sweden as elsewhere. Some 15 years ago, a proposition was put forward to the County Administrative Board to list the nuclear power plant Barsebäck as a Cultural Heritage site. The proposal was rejected as a practical joke. But times change, and in the last few years increasing interest in the history of nuclear power and nuclear power plants as cultural heritage has been shown by researchers, as well as heritage groups and the community at large. This has resulted in several national seminars to discuss the cultural and historical value of nuclear power plants. Furthermore, there are several research and field research projects in progress.

This paper will focus on the Ågesta Nuclear Combined Heating and Power Plant as an example of early nuclear politics in Sweden and as a symbol of the idea of progress that the whole nation was behind, and refers to our field research project. It will identify some questions regarding cultural values, difficulties and possibilities. How can the cultural value of nuclear power plants beextracted and analyzed? How can we make use of this in the future? Is it possible to do a full-scale preservation of a plant? The complexities of the legal restrictions concerning nuclear activity on the one hand and on the other hand heritage issues may represent a great challenge when it comes to the question of preservation.

The paper will present different perspectives on the plant. The first part of the paper begins with the political context, primarily in Sweden but to some extent also at the international level. The second part describes the site and the technology used at the

plant, and this is followed by a presentation of the cultural value of the plant. Finally, we discuss how these values can be presented at the plant in ways that comply with the legislation for cultural heritage on the one hand, and the legislation governing the nuclear industry and radioactive waste and materials on the other.

BACKGROUND

The history of nuclear power in Sweden started in the 1940s. A week before the atomic bomb was dropped in Hiroshima on 6th of August 1945, the US government petitioned the Swedish government to be given an option on Swedish uranium production or at least a guarantee of an export ban. There was an ongoing discussion about a National Nuclear Programme in Sweden but this episode made the Swedish government aware of the importance of the large deposits of uranium in Sweden and increased the interest for this issue. The Swedes answered the Americans that the Swedish state would retain control of the uranium and the use of it, but they assured the Americans that they would not export it to the USSR.

In 1946 a government commission, the Atomic Commission (*Atomkommittén*) was established. Its mission was to encourage research in physics and nuclear chemistry. In addition, a corporation, AB Atomenergi, was founded to develop the peaceful use of nuclear power. Several of the members of the Atomic Commission were connected to the Swedish Defence Research Agency (known at the time as the Swedish Defense Research Establishment). There were also several well-known scientist involved in the work. Later in 1946 the Commission tabled their first report. In 1950 some crucial governmental decisions were made: the mining of Swedish uranium was to begin in the south west part of the country and a reactor was to be built in the centre of Stockholm city. This reactor was located at the Royal institute of Technology and was connected to the Royal Swedish Academy of Engineering Sciences — at the very centre of scientific R&D in Sweden, so to speak. The reactor, named R1, was contained in a rock cavern 25 m below ground level for safety reasons. It was a research reactor, fuelled with natural uranium and moderated with heavy water. R1 was in operation until 1970. This first reactor constituted an important step towards further research and development. Because of this early step, an educated crew of young and skilful scientists and engineers was ready for the new challenges of building more complex reactors.

During the 1950s, the use of nuclear power for peaceful purposes was emphasised and encouraged. The President of the United States declared at the general assembly of UN in 1953 that the USA would offer technical information and access to uranium. The conditions on which this offer was made were that the uranium and know-how would be used to generate nuclear power for peaceful purposes. A new programme "Atoms for peace" changed the conditions for nuclear development and encouraged private initiatives. The first International Nuclear Congress was arranged in Geneva in

1955. That was a great breakthrough for international co-operation in nuclear development and classified technical information was made public for the first time. An international body for controlling atomic energy, the IAEA, was formed in 1957.

Swedish industry thus began to show interest in the development of nuclear plants. But the government declared that the state would remain in charge of all development, construction and operation of nuclear power plants. At this time, Sweden was debating whether to develop nuclear weapons or not. Those were the days of the Cold War and the rationing and restrictions of the Second World War were still fresh in people's memories. However, the need for independence was strong and led to the creation of a policy for the use of nuclear power, which came to be known as "the Swedish line". This policy will be discussed further below. The political debates on nuclear weapons continued for a decade. In the 1960s, the decision not to proceed was made. In 1968, Sweden signed the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), effectively ending the debate.

Ågesta Combined Nuclear Heating and Power Plant

Ågesta Combined Nuclear Heating and Power Plant is situated 15 km south of Stockholm city centre, close to the suburb Farsta. The Ågesta plant was constructed during the years 1957-1962. When the plant was commissioned in 1964, it was the first nuclear power reactor to produce power and heating for the market in Sweden.

The plant was designed and constructed as a joint venture by AB Atomenergi, a governmental agency named Vattenfall AB, and *Stockholms Elektricitetsverk* (Stockholm's Electric Power Company). The reactor with its associated systems was jointly financed by AB Atomenergi and Vattenfall, while the conventional part of the plant was financed by the Stockholm's electric power company. The equipment was developed and produced by various Swedish companies. The investment totalled about 200,000 million Swedish crowns. AB Atomenergi was responsible for the start-up of the reactor and its operation during its first year of operating at full power. Thereafter Vattenfall AB took charge of operations and staffing.

The Ågesta reactor was a pressurised heavy water reactor (PHWR) that used domestic natural uranium as fuel and heavy water imported from Norway as the coolant and moderator. The reactor design was influenced by the Shippingport reactor, in Pennsylvania in the USA. For safety reasons, the Ågesta reactor was put under ground in a rock cavern. The plant supplied mainly Farsta with district heating, but also produced a small amount of power for the National Electrical Power grid. The Ågesta plant was in operation from 1964 to 1974, when it was permanently shut down after 52,000 hours of operation.

THE ÅGESTA PLANT AS CULTURAL HERITAGE

The Ågesta plant today

The Ågesta plant is remarkably well preserved today, because of strict legal regulations concerning nuclear waste and contaminated material. The reactor building, which comprises a large number of storeys and is approximately 40 metres high, is contained inside a rock cavern blasted out of the steep slope of a hillside. The heavy transport access to the reactor building is through a large gate with iron ore filled steel doors. The heavy water has been tapped and sold and two steam generators have been dismantled and removed from the site for decontamination tests. Aside from that, the reactor building with all its parts is intact. The reactor building is continuously supervised and maintained.

Fig. 1. The reactor hall of the Ågesta plant. The reactor is situated under the floor of the reactor hall. At left, the fuelling machine.

Fig. 2. The control room. Its overall design is a clear example of the ideals of the 1960s.

The environment comprises a sentry box at the gates, the former laboratory and workshop, an administration building, a plant for treating contaminated waste, a combined turbine hall and condenser building and two cooling towers on top of the hill. The laboratory and workshop building and the turbine hall are connected to each other, and with the reactor building, via underground passageways. The laboratory and workshop building has been completely refurbished and few traces remains from its former use. The other buildings are well preserved. The area is currently used by the Stockholm fire brigade as a training centre.

Fig. 3. The external environment of the Ågesta plant. From left to right, the plant for treating contaminated waste, cooling tower, turbine hall and laboratory and workshop building. The reactor building is contained inside a rock cavern behind the turbine hall, beneath the cooling tower.

Fig. 4. Cooling tower. The cooling towers are situated on top of the hill, above the reactor building. Since the reactor building is hidden, the cooling towers are one of the few physical structures in the external environment that indicate the existence of a nuclear power plant.

Cultural value

The Ågesta plant is today widely recognized among scientists and in cultural heritage circles as a piece of Swedish cultural heritage of importance. It raises crucial questions concerning national independence during the Cold War in Europe, including the possibilities for small countries to make nuclear weapons. It is also an illustration of the optimism and the progress paradigm that characterized the Swedish welfare state of the 1960s, where the sky was the limit for the growth and development of Swedish industry. However, no efforts have been made so far to preserve its cultural value for future generations (this will be discussed later in this paper).

In looking at the cultural value that could be assigned to the Ågesta plant, this is, by necessity, dependent on one's choice of perspective. What stories are there to be told? Who decides what stories are told and for what reasons? In the following, we analyse the cultural value of the Ågesta plant. The aim of this analysis is to identify physical structures which are of great importance to preserve and communicate in order to tell the story that has been chosen. Our perspective will be national and international, rather then regional and local.

Method of analysis

The cultural value of a heritage object can be discussed in terms of its story-telling capabilities: to what extent can the physical remains, at different levels, help us understand and experience important parts of our history, tell us important stories about yesterday and today? Each object can tell a lot of different stories, each with a different significance. The first step in the analysis is therefore to determine the best story for the object to tell. In choosing this story, we must reflect on the object's context — historically, technologically, industrially — all of which are perspectives in relation to the status of the object. We must also make comparisons. Are there other objects, maybe many other objects, that can tell the same story but even more persuasively? Once the story has been chosen, the object can be analyzed in detail as cultural heritage. What structures are of great significance for the story and which are less important? This ranking of the physical structures assists in communicating the cultural value of the object and facilitates work on its preservation.

In this paper, the Ågesta plant is analyzed according to the following steps:

1) Its context
2) Its story
3) Comparisons with other objects

4) Ranking of the physical structures

Its context

The Ågesta plant has a number of distinctive features, all of which can be identified with the guidelines produced by a public commission of inquiry into nuclear energy (*Atomenergiutredningen*, abbreviated to AEU) carried out in the mid 1950s concerning Sweden's future use of nuclear power[1]. The Swedish parliament decided in 1956 to broadly adopt the guidelines as set down by the AEU. As a result, an official Swedish policy concerning the peaceful use of nuclear power was declared, which was subsequently often referred to as "the Swedish line" on nuclear power. The Swedish line came to have a significant impact on Sweden's understanding of itself as a neutral, independent country with a strong industrial sector and advanced technology during the 1960s.

Firstly, the AEU stated that Sweden should develop its own nuclear power capabilities for peaceful use. The reasons for this, according to the AEU, were that Sweden would thereby become less dependent on fuel imports, and that this would increase the competitiveness of Swedish industry and would cover the needs for electrical power in the future.

The use of natural uranium as fuel was strongly advocated by the AEU. Natural uranium was domestically available, which was an advantage since the prices and availability on the international market were unstable. Also, domestic uranium fuel production could be used as leverage to get better prices from overseas suppliers. The costs of building a gaseous diffusion plant for enriching uranium was too high for a small country like Sweden, but a reactor using natural uranium would make it possible to process the used fuel so that enriched fuel could be used in the development of new reactors, as enriched reactors and breeder-reactors.

When natural uranium is used as the fuel, either heavy water or graphite can be used as the moderator. The AEU recommended the use of heavy water. Graphite-moderated reactors required far more uranium, which would make them too big and expensive in periods with low heat load and they were not as safe as heavy water moderated reactors.

The AEU also suggested that, initially, Sweden should focus on small nuclear plants for district heating. From an international point of view, this was very unusual. The

[1] Atomenergien – betänkande med förslag avgivet av 1955 års atomenergiutredning. SOU 1956:11

AEU argued that small nuclear plants for district heating would be a means of efficiently decreasing Sweden's dependence on fossil fuels, especially oil. Also, it was considered difficult to produce enough heat for the turbines in a heavy water reactor. Finally, the need for electrical power in the near future could be covered by the continued exploitation of the rivers for hydro power plants.

In the 1950s and 1960s there was a lot of debate, in Sweden as well as abroad, concerning the military use of nuclear power. The AEU presented a policy for the use of nuclear power strictly for peaceful purposes, and the considerations and arguments put forward did not take a future military program into account. However, the results of the AEU suited a future military program well. Heavy water reactors are more suitable for producing plutonium then light water reactors, and with domestic uranium the whole fuel cycle could remain a purely Swedish concern. This was most probably a prerequisite for a domestic nuclear weapons program. The military aspects of domestic nuclear power capabilities are generally included in "the Swedish line".

Its story

Against the background of this context, the story chosen for the Ågesta plant is that of the official Swedish policy for the peaceful use of nuclear power in the 1950s and 1960s.

The Ågesta reactor was never used for military purposes. The plant was not used for the production of weapons-grade plutonium, and the military was not involved in the production. As early as 1958, Sweden had agreed to put the Ågesta reactor under US supervision and get cheap uranium in return. In the late 1950s another, much larger, heavy water nuclear power plant was planned, which could produce a more substantial amount of plutonium. This plant was built and completed in the late 1960s, but the reactor was never started. Nonetheless, the Ågesta plant can be considered part of a technological and industrial infrastructure that was created to keep the possibilities of producing a domestic nuclear bomb open. However, the physical remains of Ågesta do not serve to illustrate the production of Swedish nuclear weapons, nor the preparations for producing weapons-grade plutonium.

Comparisons with other objects

The Swedish policy on nuclear power that had resulted from the AEU commission of inquiry was abandoned in the late 1960s. Larger, electric power generating light water reactors were found to be more economical and efficient and in compliance with the needs. In spite of the great significance of the Swedish policy as an idea, Ågesta was,

in the end, the only nuclear power plant ever built in full compliance with the guidelines established by the AEU.

Ranking of physical structures

From an international perspective, one of the most interesting aspects of "the Swedish line" was the idea of using nuclear power for district heating. This distinguishes "the Swedish line" from the nuclear power policies of most other countries. The other features of "the Swedish line", such as the striving for national independence, were not unusual, and the use of heavy water moderated reactors with natural uranium as the fuel has an equivalent in, for example, Canada's CANDU program.

The conclusion from this is that the most important physical structures of the Ågesta plant are those showing the plant as a supplier of district heating to the suburb Farsta, along with those features that make it clear that the heat was produced in a nuclear reactor. The structures showing the reactor as moderated by heavy water and fuelled by natural uranium are also important, but have a lower priority. The structures for producing electrical power, such as transformers and turbines, are of less importance.

For a nuclear power plant to produce district heating, it must be situated close to the consumers. This, in turn, demands that the safety of the plant is satisfactory, with respect to both the internal (working) environment and the external environment. The location of the reactor in a hillside is therefore an important physical manifestation of "the Swedish line".

PRESERVATION

Cultural heritage legislation

A number of Acts and Statutes govern the preservation and protection of national heritage and the historic environment in Sweden. The Heritage Conservation Act is the core legislation for preserving Sweden's cultural heritage and contains the basic regulations for preservation of our cultural heritage. The first lines in the Act state "The care and preservation of our cultural environment is a matter of national concern. Responsibility for this is shared by all."

The Planning and Building Act allocates responsibility for historic environment issues to the municipalities. The Act stipulates that buildings with a cultural and historical interest may not be changed in any significant way.

According to the Heritage Conservation Act, the heritage authorities at the national or regional level can classify and prescribe protective provisions for sites of specific historical interest. The Ågesta plant is not listed in that way, but the Municipality of Huddinge has designated the plant as a site of cultural and historical interest in their heritage program.

Protection of cultural heritage from the second half of the 20th century has been indicated as a neglected field by the Ministry of Culture and the National Heritage Board. During the past decade, interest in our industrial heritage has increased and has become an important issue for heritage authorities and museums.

By law we are obliged to preserve objects of designated cultural and historical value. Furthermore, Ågesta plant represents a type of site and an era that the cultural heritage authorities are being encouraged to protect and preserve.

Nuclear legislation

Since the Ågesta plant is a nuclear power plant, there are several other Acts that regulate the nuclear industry and radioactive material.

Two regulatory authorities supervise nuclear facilities: the Swedish Nuclear Power Inspectorate (*Statens kärnkraftsinspektion, SKI*) is responsible for safety at nuclear power plants and nuclear waste facilities; and the Swedish Radiation Protection Authority (*Svenska strålskyddsinstitutet, SSI)* is responsible for ratifying the planned waste treatment program. SSI is responsible for the supervision of nuclear facilities even after they are closed down until they are demolished or not radioactive any longer. Before dismantlement, the SSI must approve the action to be taken and the plans for the work.

Since 1997, an Act of Parliament has been in force that regulates the decommissioning of nuclear power plants. According to this Act all of them are to be decommissioned and dismantled. The plants must be fully demolished, the ground decontaminated and the former landscape restored within a stipulated time period. The time for dismantlement is determined by how the question of what to do with the contaminated waste has been solved. It is anticipated that the Ågesta plant will be demolished in the 2020s to 2030s.

Swedish law stipulates that producers of nuclear power must pay all the expenses of decommissioning, handling and final disposal of nuclear waste, now and in the future. A financing system has been created to cover the costs of nuclear waste based on the payments to the state by the reactor licensees of a fee per kilowatt-hour of electricity produced. This fee is transferred to the consumers' electricity bills. The fee is calculated by the Swedish Nuclear Power Inspectorate (SKI) and paid into a state-owned fund that administers the funds. The size of the fee is based on the assumption that each reactor will operate for 25 years.

The Ågesta plant was built by AB Atomenergi and run by Vattenfall, . Today Vattenfall owns 50 % of the plant and SVAFO (a private company that is responsible for the future decommissioning of a couple of nuclear facilities, including the Ågesta plant) owns the other 50 %. Funds have been set aside to finance the costs of the decommissioning. These costs are estimated at 1.2 billion Swedish crowns. The decommissioning and dismantling of the Ågesta plant will be supervised by the Swedish Radiation Protection Authority (SSI) and the Swedish Nuclear Power Inspectorate (SKI). Swedish Nuclear Fuel and Waste Management Co (*Svensk kärnbränslsehantering AB*, SKB) is responsible for taking care of the nuclear waste. The work of these authorities and companies is strictly regulated by various legislation that focuses on security, safety and environmental protection. They all focus on how to get rid of the nuclear facilities in an appropriate way and restore the sites as far as possible.

What to preserve

We have pointed out that the Ågesta plant is of great cultural and historical interest and is a testimony to several important features of Sweden during the Cold War. The question is if and then how the different laws – cultural heritage legislation on the one hand and nuclear legislation on the other hand – which are so clearly in conflict with each other, can be harmonized.

Another important question is which and whose history to emphasise in the Ågesta plant or if it is possible to present several, potentially conflicting intentions with regard to the preservation. The nuclear industry has their perspective and their history focusing on the technological development and economic factors concerning the plant. But it's also important to present the history of the resistance to the building of the Ågesta plant and the later anti-nuclear movement. The technological development is quite easy to present and preserve in the physical building. The whole complex is a result of scientific and technological achievements but the control room also has a

very modern, scientific and optimistic design typical of the early 1960s. It is an exponent of the time and contemporary ideals.

The history of Ågesta plant is not complete without the people who developed, worked at or lived close to the site. When we think of nuclear power, most of us think of men in white coats. And there were many of them at the Ågesta plant. During the planning and building process, there were many scientists and engineers involved, and they were also involved in the running of the plant. But not all of the employees were engineers. There were also people who supervised the reactor, who checked the meters on the control panel and performed measurements in water and air in the surroundings. There were also administrators and clerks of various kinds – possibly even some women. To a large extent, these administrators and clerks worked in the laboratory and in the offices. These buildings have been altered to a much greater extent than the reactor building. Therefore it is more difficult to preserve the administration buildings even if the position of the buildings and their style are interesting and could be analysed. We can also access information about the employees through archives – company and trade union archives, architectural drawings, pictures and interviews. It is probably possible to present their history and place the presentation/exhibition in the existing buildings.

Fig 5: Employees at the Ågesta plant

Fig 6: The Office

The preservation of the Ågesta plant can thus present several perspectives on Sweden during the decades termed the high industrial era. A period when industry grew very rapidly and Sweden transformed into a highly industrialized nation. But if we want to preserve the reactor, what are we to do about the legislation that demands the dismantling of the reactor?

A simple solution is to preserve the site for 20 –30 years and during these years investigate, document and discuss the plant and its building. The result of this work can be presented somewhere else as well as at the site – even if the reactor is gone.

Another, more permanent solution is to focus the preservation on the high-ranked parts of the site. The most important physical remains at the Ågesta plant as identified above are those connected with district heating. In combination with the large archives describing the planning, building and running of the Ågesta plant the physical

structures can contribute new knowledge about Ågesta and Sweden's early nuclear history. It could also increase public interest in these questions.

It might be possible to demolish the radioactive parts while preserving other parts of the site. To preserve the reactor may not be the only, nor the most efficient, way to discuss important questions about the development of nuclear power in Sweden during the Cold War and the work done at the Ågesta plant. Perhaps one could build a fake reactor – to show what the real one looked like and where it was. This would be quite controversial within heritage circles in Sweden.

There is a long way to go before any solution to these problems is reached. The Ågesta plant is worth further investigation and preservation, but not only in its physical form. There are also great possibilities for gathering new knowledge: knowledge about Sweden and the Swedish use of nuclear power during these decades; but also new knowledge about how to deal with this type of industrial site and with conflicting laws and regulations.

Preserving the Ågesta plant stresses several interesting but difficult aspect about preservation of industrial plants from the second half of the 2000 century. These sites are often large, the technology complicated and not easy to comprehend for non-professionals. Further on they are often contaminated and dangerous in one way or another. The question we have raised here are of course not only of Swedish concern and we would like to continue the discussion on an international level with comparison with other countries.